A COMBINATION OF HARDWARE & SOFTWARE SYSTEM FOR DATA ACQUISITION OF ECG SIGNAL FROM THE FINGER TIP

BACHELOR OF TECHNOLOGY
IN
ELECTRONICS AND INSTRUMENTATION ENGINEERING

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CERTIFICATE

This is to certify that RAJASHREE DAS (110ei0239) of B.Tech have worked under my supervision and guidance on the project entitled "A COMBINATION OF HARDWARE & SOFTWARE SYSTEM FOR DATA ACQUISITION OF ECG SIGNAL FROM THE FINGER TIP".

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Rajashree Das

(B.Tech in Electronics and Instrumentation Engineering)

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ABSTRACT:

The goal of this project is to generate a very cheap, functional ECG machine made from common parts, most of which can be found around our house.

This project is different than the electrocardiograph.

This project greatly simplifies the circuitry by eliminating noise reduction components, accomplishing this via software-based data post-processing. The input signal is amplified, noise is removed efficiently and then we got our output signal. From the output signal, number of pulses is counted and is compared with ECG signal.

In short, this project will give us the power to visualize and analyse our own heartbeat!

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CHAPTER 1

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- **Human heart**
  - **Introduction**
  - **Parts and their functions**
  - **Blood flow**
- **Heart pulse**

HUMAN HEART AND ITS FUNCTION

Introduction

The heart could be a prevailing muscle that pumps blood throughout the body by proposes that of a synchronized contraction and relaxation. The contraction is generated by start that is unfolded by an organic phenomenon wave that spreads in a very coordinated way throughout the guts. Below out-dated conditions, the pacemaker initiates associate degree electrical impulse that spreads through the atria to the heart muscle, wherever a delay permits chamber filling before the electrical impulse issue through the particular physical phenomenon system that spreads the electrical signal at speeds of meters per second throughout the ventricles. This electrical impulse propagates diffusively through the guts and elevates the voltage at every cell, manufacturing associate degree nerve impulse, throughout that a surge in intracellular atomic number 20 initiates the mechanical contraction. the traditional rhythm is altered once one or a lot of spiral waves of electrical activity seem .These waves are grave as a result of they act as high-frequency sources and underlie advanced internal organ electrical dynamics like cardiac arrhythmia

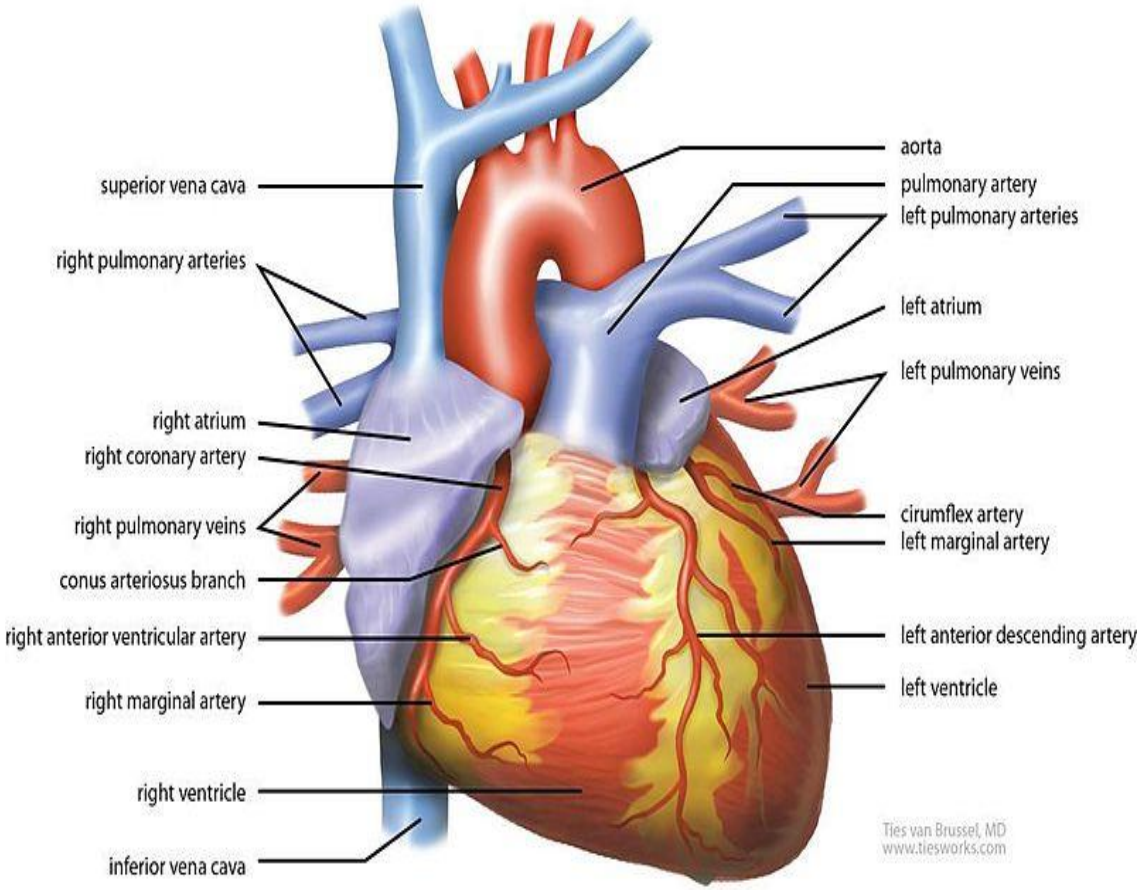


FIGURE 1-(Heart Anatomy and Structure)

Heart

A powerful muscle slightly larger than a clenched fist. It is composed of four chambers, two upper (the atria) and two lower (the ventricles). It works as a pump to send oxygen-rich blood through all the parts of the body. A human heart beats an average of 100,000 times per day. During that time, it pumps more than 4,300 gallons of blood throughout the entire body.

Right Ventricle:

The lower right chamber of the guts. Throughout the traditional oscillation, the correct ventricle receives deoxygenated blood as the right atrium of the heart contracts. Throughout this process the semilunar valve is closed, allowing the correct ventricle to fill. Once each ventricles area unit full, they contract. as the heart ventricle contracts, the right atrioventricular valve closes and therefore the semilunar valve opens. The closure of the right atrioventricular valve prevents blood from returning to the correct atrium, and therefore the gap of the semilunar valve permits the blood to flow into the pneumonic artery toward the lungs for action of the blood .The right and left ventricles contract simultaneously; however, as a result of the correct ventricle is diluent than the left, it produces a lower pressure than the left when acquiring. This lower pressure is ample to pump the deoxygenated blood the short distance to the lungs.

Left Ventricle:

The lower left chamber of the heart. During the normal oscillation, the left ventricle receives aerated blood through the mitral valve from the atrium of the heart because it contracts. At the same time, the aortic valve resulting in the artery is closed, allowing the ventricle to fill with blood. Once each ventricles area unit full, they contract. Because the left ventricle contracts, the mitral valve closes and the aortic valve opens. The closure of the mitral valve prevents blood from returning to the atrium of the heart, and the gap of the aortic valve permits the blood to flow into the artery and from there throughout the body. The left and right ventricles contract simultaneously; however, because the left ventricle is thicker than the right, it produces the next pressure than the right when catching. This higher pressure is important to pump the aerated blood throughout the body.

Right Atrium:

The upper right chamber of the heart, during the normal oscillation ,the right atrium receives deoxygenated blood from the body (blood from the head and upper body arrives through the superior venous blood vessel, while blood from the legs and lower body part arrives through the inferior venous blood vessel cava). Once each atria area unit full, they contract, and the deoxygenated blood from the right atrium flows into the right ventricle through the open

Left Atrium:

The upper left chamber of the centre. Throughout the normal cardiac cycle, the atrium of the heart receives ventilated blood from the lungs through the pulmonic veins. Once both atria square measure full, they contract, and also the ventilated blood from the atrium of the heart flows into the left ventricle through the open bicuspid valve.

Superior venous blood vessel Cava:

One of the 2 main veins transfer deoxygenated blood from the body to the centre. Veins from the head and upper body feed into the superior vein that empties into the correct atrium of the centre.

Inferior venous blood vessel Cava:

One of the 2 main veins transfer deoxygenated blood from the body to the centre. Veins from the legs and lower body part feed into the inferior vein, that empties into the correct atrium of the centre.

Aorta:

The central conduit from the center to the body, the arteria carries ventilated blood from the left ventricle to the assorted elements of the body because the left ventricle contracts. Attributable to the large pressure created by the left ventricle, the arteria is that the largest single vas in the body and is close to the diameter of the thumb. The aorta proceeds from the left ventricle of the center through the chest and thru the abdomen and ends by dividing into the 2 common bone arteries, that still the legs.

Atrial septum:

The wall between the 2 upper chambers (the right and left atrium) of th center.

Pulmonary trunk:
A vessel that conveys deoxygenated blood from the correct ventricle of the heart to the correct and left pulmonic arteries, that proceed to the lungs. When the right ventricle contacts, the blood inside it's drug pressure and also the atrioventricular valve between the correct atrium and heart ventricle closes. the sole exit for blood from the correct ventricle is then through the pulmonary trunk. The blood vessel structure stemming from the pulmonary trunk is that the only place in the body where arteries transport deoxygenated blood.

Pulmonary veins:
The vessels that transport ventilated blood from the lungs to the left atrium. The pulmonic veins square measure the sole veins to hold ventilated blood.

Pulmonary Valve:
One of the four one-way valves that keep blood moving properly through the assorted chambers of the center. The pulmonary valve separates the correct ventricle from the arterial blood vessel. because the ventricles contract, it opens to permit the deoxygenated blood collected in the heart ventricle to flow to the lungs. It closes because the ventricles relax, preventing blood from returning to the center.

Aortic Valve:
One of the four one-way valves that keep blood moving properly through the various chambers of the center. The semilunar valve, conjointly known as a semi-lunar valve, separates the left ventricle from the arteria. because the ventricles contract, it opens to permit the ventilated blood collected in the left ventricle to flow throughout the body. It closes as the ventricles relax, preventing blood from returning to the center. Valves on the heart's left facet have to be compelled to withstand abundant higher pressures than those on the correct facet. Sometimes they can wear out and leak or become thick and stiff.

Mitral Value:

One of the four one-way valves that keep blood moving properly through the various chambers of the center. The bicuspid valve separates the atrium of the heart from the left ventricle. It opens to permit the ventilated blood collected in the atrium of the heart to flow into the left ventricle. It closes because the left ventricle contracts, preventing blood from flowing backwards to the atrium of the heart and thereby forcing it to exit through the semilunar valve into the aorta. The bicuspid valve has small cords connected to the walls of the ventricles. This helps support the valve's small flaps or leaflets.

Tricuspid Valve:

One of the four one-way valves that keep blood moving properly through the assorted chambers of the center. placed between the correct atrium and also the
right ventricle, the atrioventricular valve is that the 1st valve that blood encounters because it enters the heart. When open, it permits the deoxygenated blood collected in the right atrium to flow into the correct ventricle. It closes because the heart ventricle contracts, preventing blood from flowing backwards to the correct atrium, thereby forcing it to exit through the pulmonic valve into the arterial blood vessel.

Atria:

The two upper internal organ chambers that collect blood getting into the center and send it
to the ventricles. the correct atrium receives blood from the superior vein and inferior vein. The atrium of the heart receives blood from the pulmonic veins. Unlike the
ventricles, the atria serve as assortment chambers instead of as primary pumps, so they
are dilutant and don't have valves at their inlets.

Ventricles:

The two lower internal organ chambers that collect blood from the upper chambers
(atria) and pump it out of the center. as a result of the ventricles pump blood removed from the heart, they have thicker walls than the atria in order that they can withstand the associated higher blood pressures. the correct ventricle

pumps oxygen-poor blood through the pulmonary artery and to the lungs. The left ventricle pumps oxygen-rich blood through the arteria and to the remainder of the body.

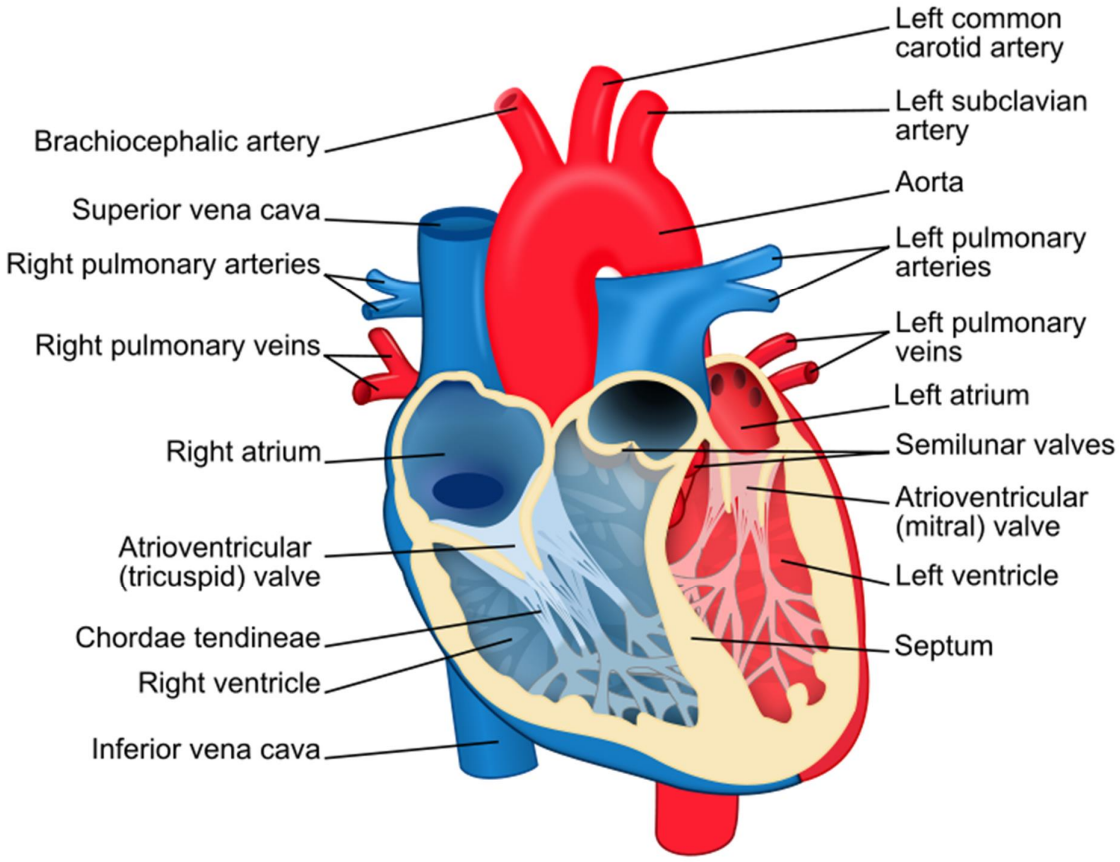


FIGURE 2 (Transverse section of heart)

Blood Flow

The circulatory system is an organ system that permits blood and lymph circulation to transport nutrients (such as amino acids and electrolytes), oxygen, carbon dioxide, hormones, blood cells, etc. to and from cells in the body to nourish it and help to fight diseases, stabilize body temperature and pH, and to maintain homeostasis.
The heart's cycle begins once oxygen-poor blood from the body flows into the correct
atrium. Next the blood flows through the correct atrium into the correct

ventricle, that serves as a pump that sends the blood to the lungs.Within the lungs, the blood releases waste gases and picks up atomic number 8. This recently oxygen-rich blood returns from the lungs to the left atrium through the pulmonic veins.

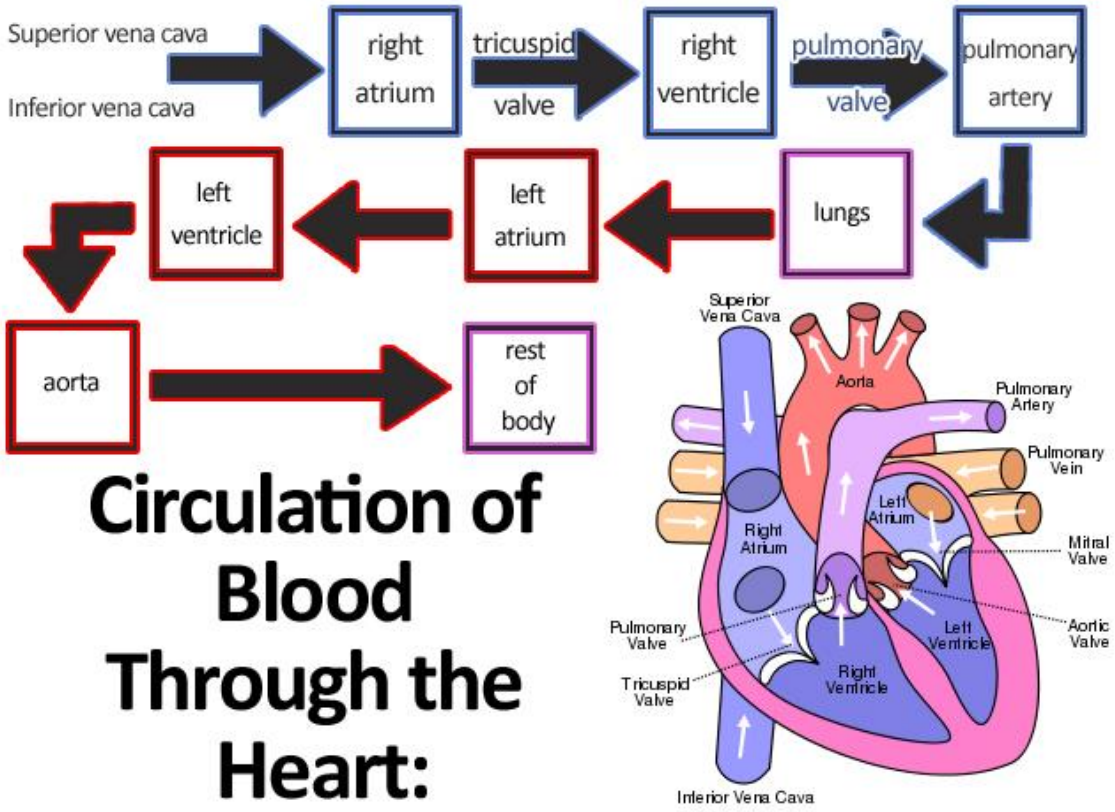


Figure-3(CIRCULATION OF BLOOD THROUGH HEART)

Palpation - the apex beat, thrills, pulsations of the guts and nice arteries that ar transmitted to the chest wall; analysis of the viscus size

- **Percussion** - deciding viscus size, particularly within the absence of an top beat.

- **Auscultation-**The modern biaural medical instrument - diaphragm for prime frequencies, bell for low or lower frequencies.
- When the bell is applied with just enough pressure to make a skin seal, low frequencies are accentuated; when the bell is ironed firmly, the stretched skin becomes a diaphragm, damping low frequencies. Variable pressure with the bell provides a range of frequencies from low to medium.
- The topographical areas for diagnostic technique, regardless of viscus situs, ar best selected by descriptive terms - viscus apex, left and right bone borders interspace by interspace, and subxiphoid.
- During diagnostic technique, the examiner is generally on the patient's right; three positions ar routinely employed: left lateral posture (assuming left body part heart), supine, and sitting.
- Auscultation should begin by applying the medical instrument to the viscus apex with the patient within the left lateral posture position.
- Simultaneous touching of the arterial pulse is important since the pulse wave is almost synchronous with the primary heart sound

HEART PULSE:

Pulse represents the tactile blood vessel touching of the heartbeat by trained fingertips. the heartbeat is also palpated in anywhere that permits Associate in Nursing artery to be compressed against a bone, like at the neck (carotid artery), on the within of the elbow (brachial artery), at the gliding joint (radial artery), at the groin (femoral artery), behind the knee (popliteal artery), close to the gliding joint (posterior leg bone artery), and on foot (dorsal is pedals artery). Pulse (or the count of blood vessel pulse per minute) is adoring activity the center rate. The center rate also can be measured by paying attention to the center beat directly (auscultation), historically employing a medical instrument and investigating it for a moment. The study of the heartbeat is understood as sphygmology.

Physiology:

The pulse may be a emphatically low tech/high yield Associate in Nursing antediluvian term still helpful at the side in an age of machine analysis of internal organ performance. Emperor of Rome anatomist was maybe the primary biologist to explain the heartbeat. The heartbeat is Associate in nursing expedient tactile methodology of determination of beat vital sign to a trained observer. Pulse vital sign is non-palpable and unperceivable by tactile ways, occurring between heartbeats. Pressure waves generated by the center in pulsation moves the blood vessel walls. Forward movement of blood happens once the boundaries square measure pliable and compliant. These properties type enough to make a palpable pressure wave. The center rate is also larger or lesser than the heartbeat rate relying upon physiological demand. During this case, the center rate is set by listening or audible sounds at the center apex, during which case it's not the heartbeat. the heartbeat deficit (difference between heart beats and pulsations at the periphery) is set by coinciding touching at the arterial and listening at the center apex. it should be gift just in case of premature beats or arrhythmia. Pulse speed, pulse deficits and far a lot of physiological knowledge square measure without delay and simplistically visualized by the utilization of 1 or a lot of blood vessel catheters connected to a electrical device and cathode-ray oscilloscope.

This invasive technique has been normally utilized in medical care since the Seventies. The rate of the heartbeat is ascertained Associate in Nursing measured by tactile or visual means that on the surface of an artery and is recorded as beats per minute or M.M..

The heartbeat is also more indirectly ascertained underneath light-weight absorbance of varied wavelengths with allotted and inexpensively reproduced mathematical ratios.

Applied capture of variances of sunshine signal from the blood element haemoglobin underneath ventilated vs. deoxygenated conditions permits the technology of pulse measuring device.

Characteristics of pulse:

- RR interval- The interval between AN R wave and therefore the next R wave; traditional resting pulse is between sixty and a hundred M.M. – period zero.6 to 1.2 s

- P wave- throughout traditional chamber change, the most electrical vector is directed from the heart muscle towards the Av node and spreads from the correct atrium to the atrium sinistrum. This turns into the P wave on the graph.- period 80ms

- PR interval-The PR interval is measured from the start of the P wave to the start of the QRS complicated. The PR interval reflects the time the electrical impulse takes to travel from the sinus node through the Av node and coming into the ventricles. The PR interval is, therefore, a decent estimate of Av node function- period -120 to 200ms

- PR section- The PR segment connects the P wave and therefore the QRS complicated. The impulse vector is from the Av node to the bundle of His to the bundle branches so to the Purkinje fibers. This electrical activity doesn't manufacture a contraction directly and is just traveling down towards the ventricles, and this shows up flat on the graph. The PR interval is additional clinically relevant. Duration- fifty to a hundred and twenty ms

- QRS complicated- The QRS complex reflects the fast change of the correct and left ventricles. The ventricles have an outsized muscle mass compared to the atria, that the QRS complicated typically encompasses a abundant larger amplitude than the P-wave. Duration-80 to a hundred and twenty ms

- J-point-The purpose at that the QRS complicated finishes and therefore the ST section begins. it's wont to live the degree of ST elevation or depression gift. Duration- N/A

- ST Segment-The ST section connects the QRS complicated and therefore the T wave. The ST section represents the amount once the ventricles ar depolarized. it's isoelectric. period eighty to a hundred and twenty ms

- T wave-The T wave represents the repolarization (or recovery) of the ventricles. The interval from the start of the QRS complicated to the apex of the T wave is observed because the absolute biological time. The second half of the T wave is observed because the relative biological time (or vulnerable period). Duration-160ms

- ST interval-The ST interval is measured from the J purpose to the tip of the T wave. Duration- 320ms

- QT interval-The QT interval is measured from the start of the QRS complicated to the tip of the T wave. a protracted QT interval could be a risk issue for cavum tachyarrhythmia's and overtime. It varies with pulse and, for clinical relevancy, needs a correction for this, giving the QTc. Duration- Up to 420 ms in pulse of sixty M.M.

- U wave-The U wave is hypothesized to be caused by the repolarization of the interventricular septum. It usually encompasses a low amplitude, and even additional usually is totally absent. It continually follows the T wave, and conjointly follows an equivalent direction in amplitude. If it's too outstanding, suspect symptom, hypercalcaemia or thyrotoxicosis.

- J wave-The J wave, elevated J-point or Osborn wave seems as a late delta rhythm following the QRS or as atiny low secondary R wave. it's thought of pathognomonic of physiological state or hypercalcaemia.

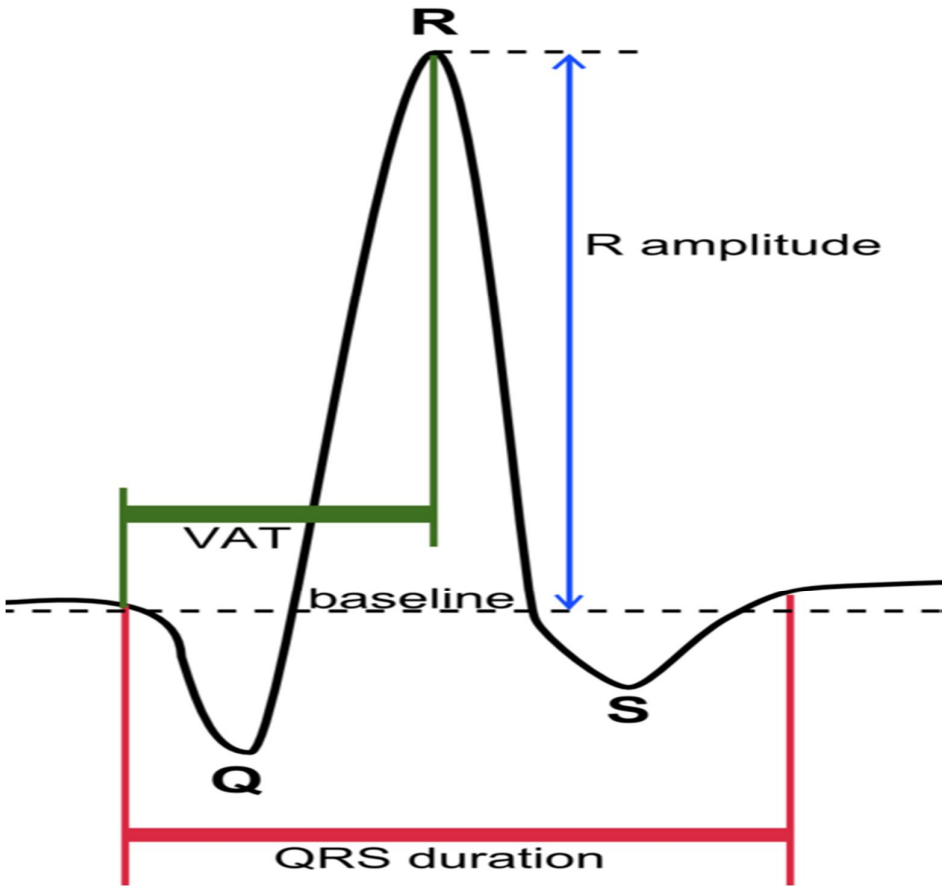


FIGURE 4-(PQRST DURATION)

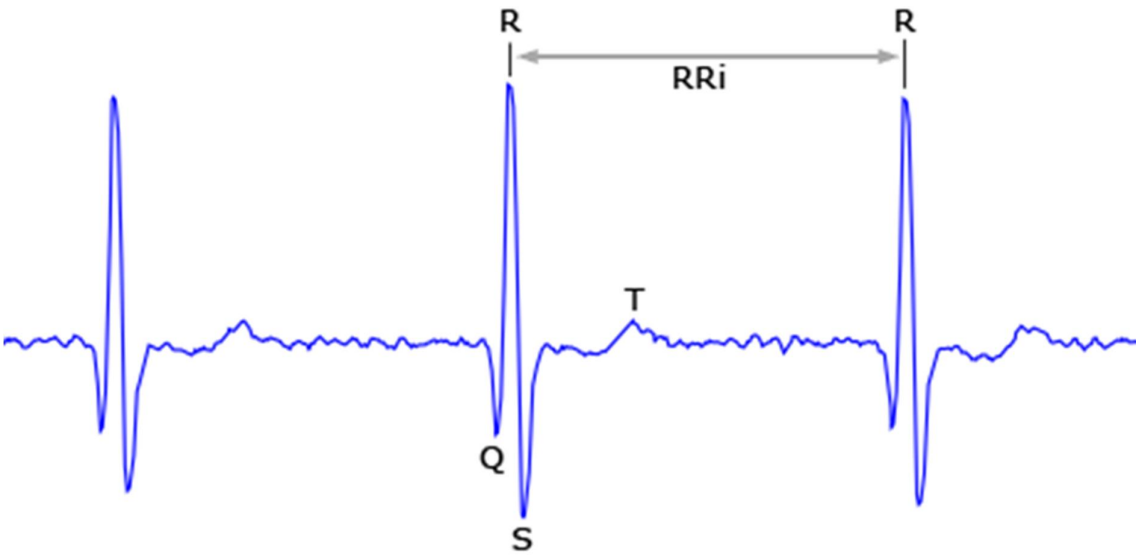


FIGURE 5 - HEART PULSE

Rate: traditional pulse rates at rest, in beats per minute (BPM):

- Newborn: (0–3 months old)- 100-150
- Infants: (3 – vi months)- 90–120
- Infants: (6 – twelve months) - 80-120
- Children: (1 – ten years)- 70–130
- Children: over ten years- 60–100
- adults, as well as seniors well-trained adult athletes- 40–60

The pulse rate are often wont to check overall heart health and fitness level. usually lower is healthier, however bradycardias are often dangerous. Symptoms of a hazardously slow heartbeat embody weakness, loss of energy and fainting.

CHAPTER-2

ELECTROCARDIOGRAPHY

- **FUNCTION OF ECG**
- **ELECTROCARDIOGRAM**
- **NOISE IN ECG SIGNAL**

Electrocardiography:

(ECG or graphical record from Greek: kardia , which means heart) is that the recording of the electrical activity of the center. historically this is often within the variety of a transthoracic (across the thorax or chest) interpretation of the electrical activity of the center over a amount of your time, as detected by electrodes connected to the surface of the skin and recorded or displayed by a tool external to the body.

The recording created by this noninvasive procedure is termed associate graph (also graph or EKG). It's potential to record ECGs invasively victimization associate implantable loop recorder.

Associate graph is employed to live the heart's conduction system. It picks up electrical impulses generated by the polarization and depolarization of viscous tissue and interprets into a wave form.

The wave form is then wont to live the speed and regularity of heartbeats, moreover because the size and position of the chambers, the presence of any harm to the center, and therefore the effects of medication or devices wont to regulate the center, like a pacemaker.

Most ECGs ar performed for diagnostic or analysis functions on human hearts however might also be performed on animals, typically for designation of heart abnormalities or analysis.

Function of ECG:

Associate graph produces a pattern reflective the electrical activity of the center and frequently needs a trained practicing to interpret it within the context of the signs and symptoms the patient presents with.

It will offer info relating to the rhythm of the center (whether or not the electrical impulse systematically arises from the a part of the center wherever it ought to and at what rate), whether or not that impulse is conducted ordinarily throughout the center, or whether or not any a part of the center is tributary a lot of or but expected to the electrical activity of the center. It also can offer info relating to the balance of salts (electrolytes) within the blood or perhaps reveal issues with metal channels at intervals the center muscle cells.

Fashionable graph machines typically embody analysis software package that makes an attempt to interpret the pattern however the diagnoses this produces might not continually be correct.

It's one amongst the key tests performed once a coronary failure (myocardial infarct or MI) is suspected; the graph will establish whether or not the center muscle has been broken in specific areas, although not all areas of the center are coated.

The graph cannot faithfully live the pumping ability of the center, that ultrasound-based (echocardiography) or medical specialty tests are used. It's potential for a person's or alternative animal to be in asystole, however still has a standard graph signal (a condition referred to as breathless electrical activity).

Electrocardiogram

Electrocardiogram (ECG) could be a designation tool that reported the electrical activity of heart recorded by skin conductor. The morphology and rate reflects the viscous health of human heart beat. It's a noninvasive technique which means this signal is measured on the surface of body that is employed in identification of the center diseases. Any disorder of rate or rhythm, or amendment within the morphological pattern, is a sign of heart disease that may be detected by analysis of the recorded graph wave form. The amplitude and period of the P-QRS-T wave contains helpful info concerning the character of illness afflicting the center. The electrical wave is attributable to depolarization and re polarization of Na+ and k+ ions within the blood. The graph signal provides the subsequent info of a person's heart:

- heart position and its relative chamber size
- impulse origin and propagation
- heart rhythm and physical phenomenon disturbances
- extent and site of heart muscle ischemia
- changes in solution concentrations
- Drug effects on the center.

ECG doesn't afford information on viscous contraction or pumping operate.

Leads in cardiogram

The standard cardiogram has twelve leads: which has three - bipolar leads, three - increased unipolar leads and three - chest (precordial) leads. A lead may be a try of electrodes (+ve & -ve) placed on the body in selected Associate in Nursing atomically locations & connected to an cardiogram recorder. Bipolar leads: record the potential between 2 points (+ve & -ve poles). Unipolar leads: record the electrical potential at a selected purpose by suggests that of one exploring conductor.

Leads I, II and III square measure usually remarked bipolar leads as they use solely 2 electrodes to derive a read. One conductor acts because the positive conductor whereas the opposite because the negative conductor (hence bipolar).

Physiologist leads:

- Lead I: records potentials between the left and right arm,
- Lead II: between the proper arm and left leg, and
- Lead III: those between the left arm and left leg

Goldberger leads square measure unipolar increased limb leads within the frontal plane. unipolar Limb leads: (when the +ve terminal is on the proper arm: aVR, left arm aVL, or left leg, aVF) One lead connected to +ve terminal acts because the totally different conductor, whereas the opposite 2 limbs square measure connected to the –ve terminal function the indifferent (reference) conductor. Wilson leads (V1–V6) square measure unipolar chest leads positioned on the left facet of the thorax in an exceedingly nearly horizontal plane. The indifferent conductor is obtained by connecting the three commonplace limb leads. Once employed in combination with the unipolar limb leads within the frontal plane, they supply a 3 dimensional read of the integral vector

Chest (precordial) leads:

- V1: fourth intercostal house, right edge.
- V2: fourth intercostal house, left edge.
- V3: between the 2d and fourth electrodes.
- V4: fifth intercostal house within the middle bone line.
- V5: on fifth rib, anterior axillary line.
- V6: within the middle axillary line.

To make recordings with the chest leads (different electrode), the 3 limb leads square measure connected to create Associate in nursing

indifferent conductor with high resistances. The chest leads primarily discover potential vectors directed towards the rear. These vectors square measure hardly detectable within the frontal plane. Since the mean QRS vector is sometimes directed downward and towards the left back region, the QRS vectors recorded by leads V1–V3 square measure typically negative, whereas those detected by V5 and V6 square measure positive. In leads V1 and V2, QRS = -ve as a result of, the chest conductor in these leads is nearer to the bottom of the guts, that is that the direction of negativity throughout most of the cavity depolarization method. In leads V4, V5, V6, QRS = +ve as a result of the chest conductor in these leads is nearer the guts apex, that is that the direction of electro quality throughout most of depolarization.

Waves Representation

P wave- The grade of this voltage signal wave is low (approximately 1mV) and represent depolarization and contraction of the correct and left atria. a transparent P wave before the QRS complicated represents sinus rhythm. Absence of P waves might recommend fibrillation, practical rhythm or cavity rhythm. it's terribly tough to investigate P waves with a high signal/noise in ECG signal.

QRS complicated- The QRS complex is that the largest voltage deflection of roughly 10– twenty mV however might vary in size counting on age, and gender. The voltage amplitude of QRS complicated might also offer data regarding the viscous sickness. Period of the QRS complicated indicates the time for the ventricles to depolarize and will offer data regarding physical phenomenon issues within the ventricles like bundle branch block.

T wave- Represents cavity repolarization. Massive T waves might represent anemia, and symptom.

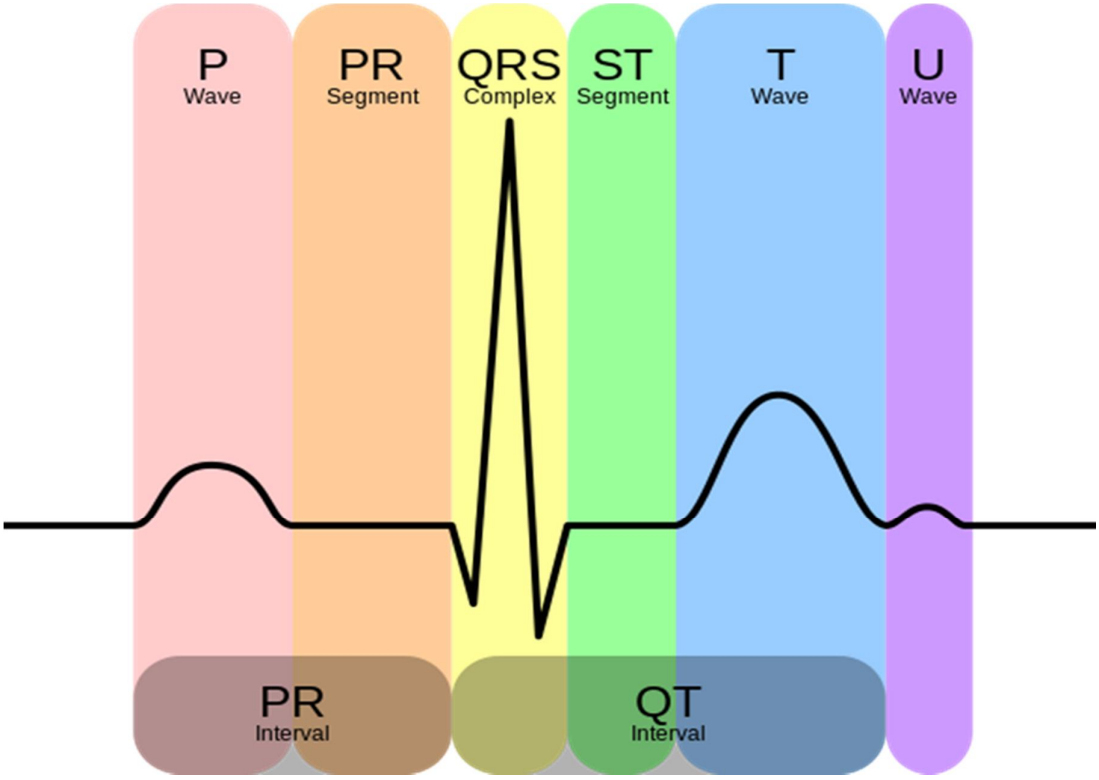


FIGURE 6- ECG SIGNAL

Noise in ECG Signal

Generally the recorded EKG signal is commonly contaminated by differing kinds of noises and artifacts that may be at intervals the band of ECG signal, which can modification the characteristics of ECG signal. Thence it's tough to extract helpful data of the signal. The corruption of ECG signal is thanks to following major noises:

Line interferences

Power line interferences contains sixty Hz pickup or fifty Hz pickup attributable to improper grounding. It indicated as Associate in nursing impulse or spike at sixty Hz/50 Hz harmonics, and can seem as further spikes at integral multiples of the elemental frequency. Its frequency content is sixty Hz/50 Hz and its harmonics, amplitude is up to fifty % of peak-to-peak ECG signal amplitude. A sixty Hz notch filter are often used take away the ability line interferences.

Baseline drift

Base-line drift could also be caused in chest-lead ECG signals by coughing or respiration with massive movement of the chest or once associate in nursing arm or leg is moved within the case of limb-lead ECG acquisition. Base-line drift will typically cause by variations in temperature and bias within the instrumentation and amplifiers. Its frequency vary usually bellows zero.5 Hz. to get rid of baseline drift a high pass filter with cut-off frequency zero.5 Hz is employed.

Motion artifacts

Motion artifacts square measure transient baseline modification thanks to conductor skin electrical phenomenon with conductor motion. It will generate larger amplitude signal in ECG wave shape. The height amplitude of this object is five hundred % of Peak to Peak ECG amplitude and its period is regarding one hundred – five hundred. Associate in nursing adaptation filter are often wont to take away the interference of motion artifacts.

CHAPTER 3

DATA ACQUISITION OF ECG

- **ELECTRICAL THEORY**
- **GOAL**
- **CIRCUIT DESCRIPTION**
- **RESULT**
- **HEART RATE MEASURING**
- **CALCULATION**
- **CONCLUSION**

DATA ACQUISITION OF ECG SIGNAL

Electrical Theory

Measurement: The electrical signals that command the heart beat are often detected from the finger tip. In theory one might grab the heart beat. however the signals square measure very weak (a few millionths of a volt) and tough to find with easy devices. Therefore, amplification is required.

Amplification: Easy thanks to amplify the electrical distinction between 2 points are to use Associate in Nursing operational electronic equipment, otherwise referred to as Associate in Nursing op-amp. The gain (multiplication factor) of Associate in Nursing op-amp is controlled by variable the resistors hooked up to that, Associate in Nursingd an op-amp with a gain of one thousand can take a one potential unit signal and amplify it to one potential unit. There square measure many alternative sorts of silicon chip op-amps, and they're usually prepacked with multiple op-amps in one chip (such because the quad-op-amp lm324, or the dual-op-amp lm358n). Any op-amp designed for low voltage can do for our functions, and that we solely want one.

Noise: sadly, the center isn't the sole supply of voltage on the finger tip. Radiation from a spread of things (computers, cell phones, lights, and particularly the wiring in your walls) is absorbed by your skin and is measured together with your ECG, in several cases masking your ECG in a very ocean of electrical noise. the normal technique of eliminating this noise is to use difficult analog electronic equipment, however since this noise incorporates a characteristic, repeating, high-frequency wave pattern, it are often separated from the ECG (which is way slower in comparison) mistreatment digital signal process laptop software!

GOAL:

The aim of this project is to gather heartbeat info on a pc with minimal price and negligible quality. It helps each as a light-based heartbeat monitor (similar to a pulse measuring system, although it's not planned to quantitatively live blood O saturation), And an cardiogram (ECG) to envision electrical activity generated.

CIRCUIT DESCRIPTION:

I take benefit of a bright red junction rectifier to shine light-weight through finger and be detected by a phototransistor. Basically the phototransistor acts sort of a resistor that conducts completely different quantities of current betting on what amount light-weight it gets.

This changes the voltage higher than it in an actual manner that changes with heartbeats. If this little signal is employed because the input, this device acts sort of a pulse measuring system.

The core of the circuit is an LM324 quad op amp chip.

This project utilizes one in all the op-amps as a virtual ground. One criticism of mistreatment op-amps in straightforward comes is that they classically want + and – voltages. Yeah, this might be through with 2 9V batteries to come up with +9V and -9V, however i feel it's easier to use one power supply (+ and GND). some way to induce around that's to use one in all the op-amps as a current supply and feed it half the facility offer voltage (VCC), and use the output as a virtual ground (allowing VCC to + and 0V GND to -). For a decent description of a way to try this showing intelligence, scan the only offer op amps web content. The caveat is that signals ought to stay around VCC/2, which might be done if it's decoupled by feeding it through a series electrical device. The project works at 12V or 5V, however was designed for (and has far better output) at 12V.

3 op-amps of the LM324 attend three unique purposes:

STAGE 1: Pre-amplifier circuit.

The input signals from either the pulse measuring instrument area unit fed into a order of three op amp stages. The primary could be a

preamplifier. The output is decoupled through a series condenser to position it close to VCC/2, and amplified greatly because of the one.8Mohm feedback resistance. Dynamical this price changes initial gain.

STAGE 2: Active low-pass filter.

The 10kOhm resistor helps you to change the frequency cutoff. The op amp is a unity gain current supply / voltage follower that has high input electric resistance once mensuration the output of the low-pass filter and reproduces its voltage with a coffee electric resistance output. There's some a lot of data concerning active filtering on this page. It's best to appear at the output of this stage and change the potentiometer till the 60Hz noise (caused by the AC wiring within the walls) is most reduced whereas the lower-frequency element of your heartbeat is preserved. With the measuring instrument, just about no noise gets through. as a result of the EKG signal is far smaller, this filter must be less aggressive, and this noise is filtered-out by software system.

STAGE 3: final electronic equipment with low-pass filter.

it's a gain of ~20 (determined by the magnitude relation of the one.8kOhm to 100Ohm resistances) and lowpass filtering elements area unit provided by the 22uF condenser across the feedback resistor. If we have a tendency to try and run this circuit at 5V and wish a lot of gain (more voltage swing), contemplate increasing the worth of the one.8kOhm resistance (with the condenser removed). Once a decent gain is obtained, completely different condenser values area unit additional till our signal is left however the noise reduced.

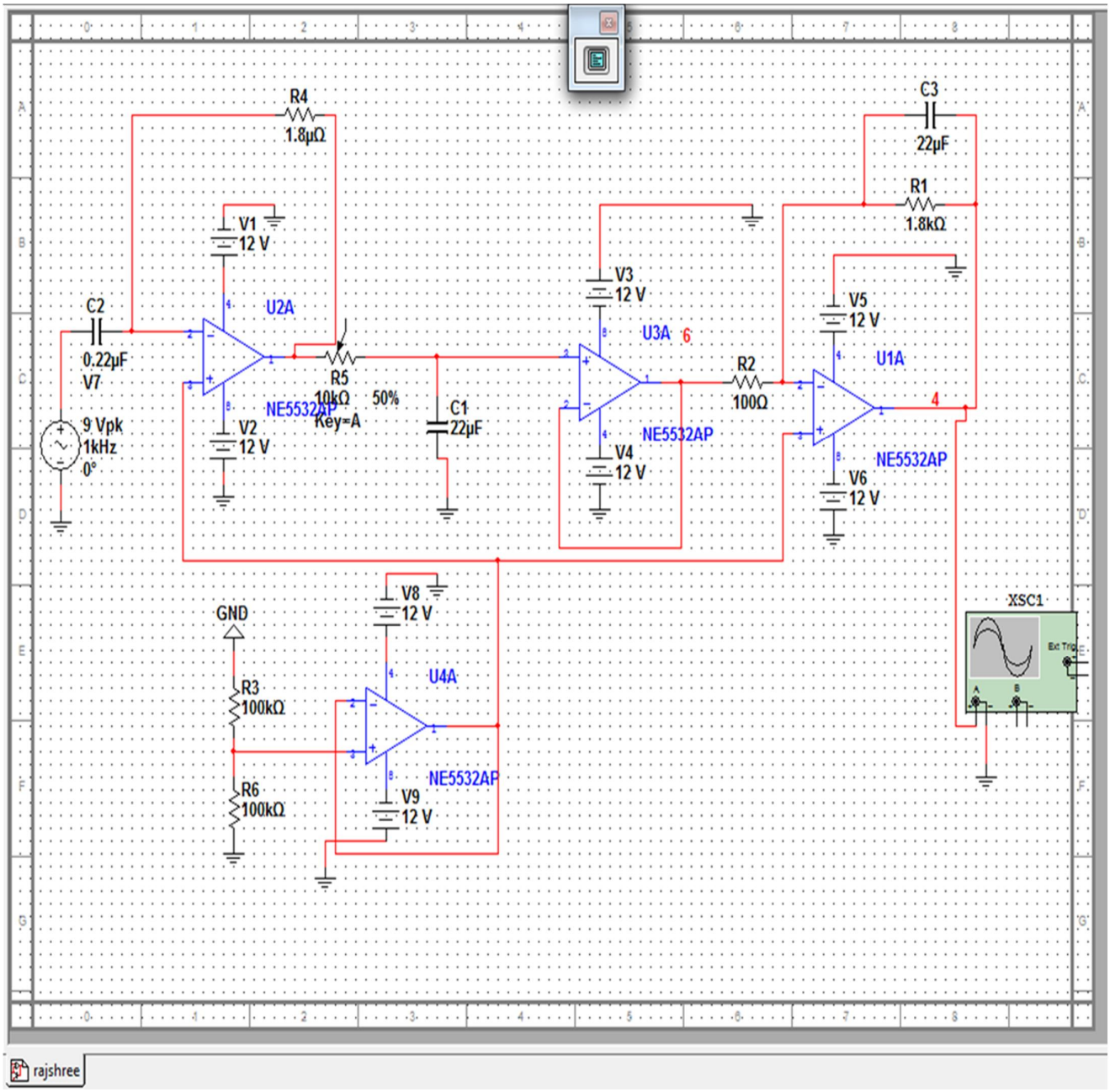
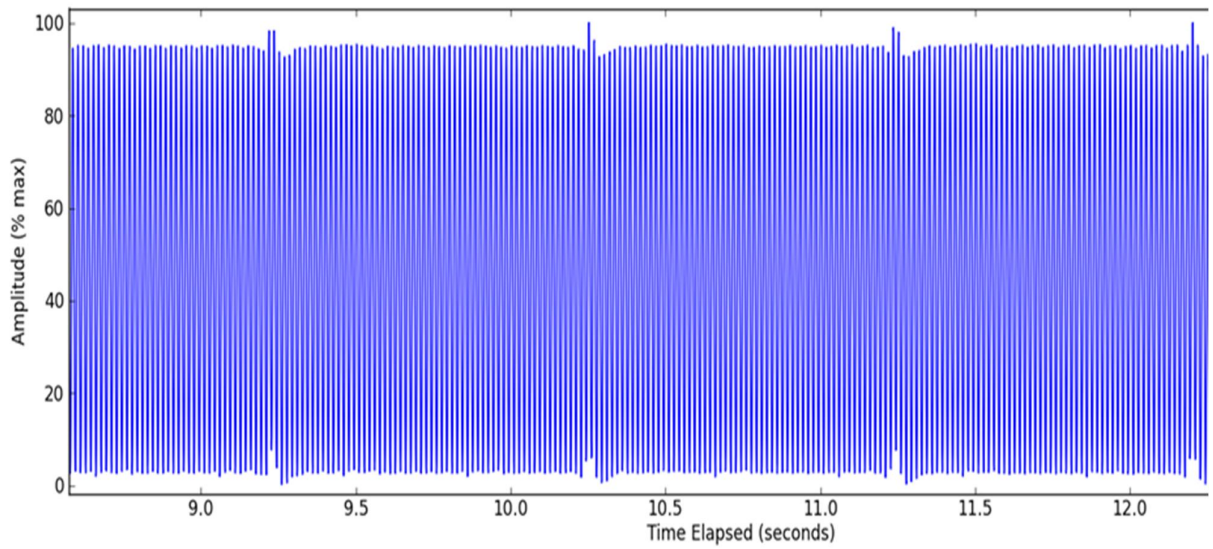


FIGURE SCHEMATIC DIAGRAM OF THE CIRCUIT

RESULT:

OUTPUT OF PREAMPLIFIRE CIRCUIT: (STAGE 1):

UNFILTERED PULSE WAVEFORM-

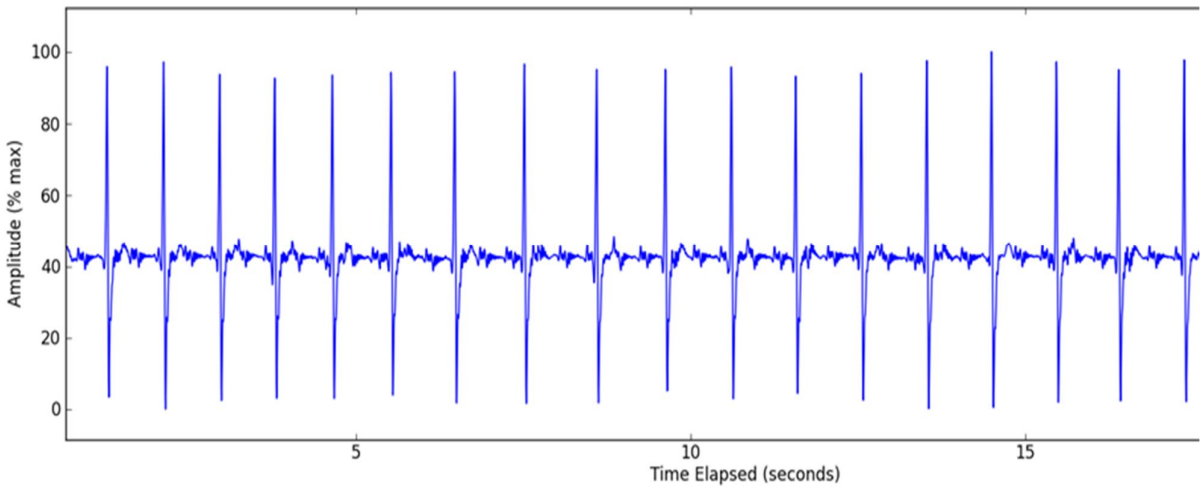


The graph gives a relation between amplitude and time (seconds). This is the output of pre-amplifier in which the small signal gets amplified.
Here the pre-amplifier circuit act as a differentiator circuit.

The **differentiator** circuit is designed to get the output of the circuit is approximately directly proportional to the rate of change (the time derivative) of the input. This is a passive differentiator circuit is made of only resistors and capacitors.

OUTPUT OF LOW PASS FILTERED CIRCUIT: (STAGE 2):

FILTERED WAVEFORM

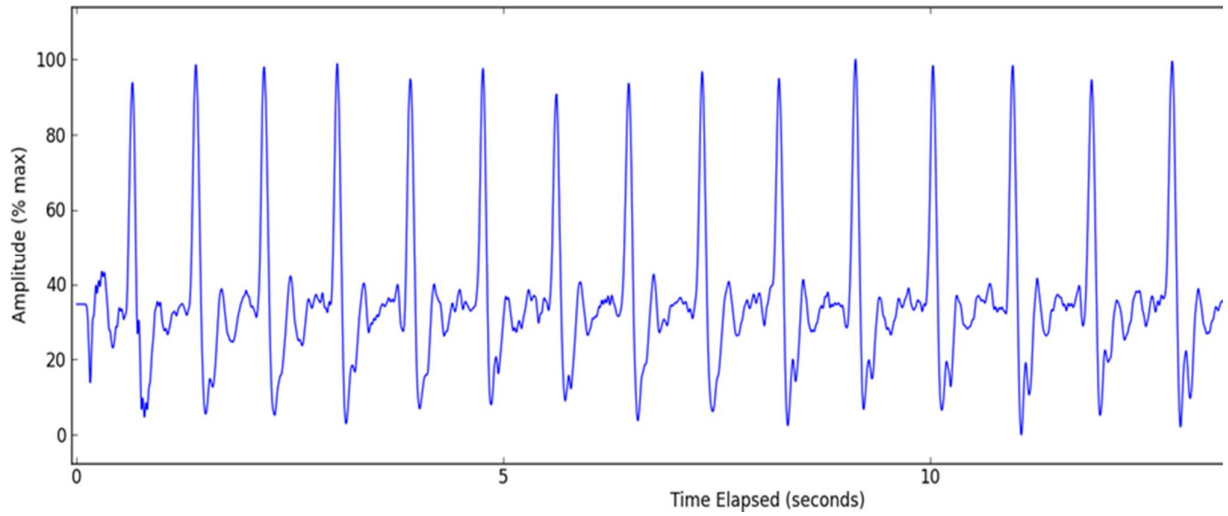


The active low pass filter, passes low frequency signals and reduces the amplitude of signals with frequencies higher than the cut-off frequency(till 60Hz noise).

The graph gives the filtered form of the output of pre-amplifier circuit.

OUTPUT OF LOW PASS FILTERED AND INTEGRATED CIRCUIT: (FINAL STAGE):

INTEGRATED FILTERED WAVEFORM



In the initial stage (in stage 1) we differentiate the input signal. Therefore in the final in order to get an desired output we integrated the output signal of the active low pass filter.

The integrator circuit which has significant gain 20 nearly equal. By changing the value of the capacitor used in the circuit we filtered out our desired frequency. And the external noise signal can be eliminated.

HEART RATE MEASURING:

The reading of the duration in between two identical points of the final waveform.

This duration is divided by 60 gives the heart rate.

Also there is another way to calculate rate. We count the total number of peaks in 10 seconds and the multiply it with 6.

RATE=(60/peak to peak interval)

CALCULATION:

As we see in the final graph.

Time taken in between two consecutive peaks is 0.8second

Now

RATE= 60/0.833= 72.02

Total number of peaks in 10 seconds is= 12

Then multiply with 6 to get number of peaks in 60 seconds

RATE= 12*6= 72

CONCLUSION:

In the first stage, the pre-amplifier circuit is a differentiator circuit which amplifies the input voltage 9v approximately 10 times as shown .In the second stage, the low pass circuit attenuates high frequencies and low frequencies are passed. The final stage of circuit is an integrator circuit which also has a significant gain 20, the capacitor value was adjusted such that noise is eliminated effectively and thus ECG pulse is generated by reducing noise and giving a significant gain to the input pulse

FUTURE WORK:

First, it'd be cool to reduce everything with surface to bring this stuff all the way down to the scale of a token. Second, improved finger, toe, or ear clips (or even taped-on sensors) over long period would supply a fairly attention-grabbing thanks to analyse pulse variability or modulation in response to worry, sleep pane, etc. rather than feeding the signal into a laptop, one might send it to an easy detector electronic equipment circuit for process or else, this knowledge might be graphed on a graphical LCD for associate degree all-in-one very little device that doesn’t need a laptop. Yep, several doable comes will use this as a start line.

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